

A New Approach to HVAC Design: Benchmarking and the MLM (Most Likely Maximum) Method

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Project Management Challenge: Over Sizing of HVAC Plants

◆ Example 1:

Laboratory Building Chiller Sizing

- Design engineer estimate
1,200 tons
- Installed capacity
600 tons
- Actual maximum load
300 tons
- Typical load
< 150 tons?

◆ Example 2:

Computer Science Building Chiller Sizing

- Design engineer estimate
?
- Installed capacity
400 tons
- Actual maximum load
200 tons
- Typical load
< 100 tons

Project Management Challenge: Over Sizing of HVAC Plants

◆ Example 3:

Laboratory Building Boiler Sizing

- Design engineer estimate*
18 modular boiler units
- Installed capacity
11 modular boiler units
- Actual maximum load
7 modular boiler units

* original estimate by energy consultant was 8 boiler units

◆ Example 4:

Office Building Fan Sizing

- Design engineer estimate
varying size VAV
- Installed capacity
each system one size smaller
- Actual maximum load
25-65%

Project Management Challenge: Over Sizing of HVAC Plants

◆ Example 5:

Laboratory Building Chiller Sizing

- Original estimate
500 tons
- Installed capacity
500 tons
- Actual maximum load*
50 tons

*equipment removed from
building program before
design complete

◆ Example 6:

Electronics Fab Expansion Chiller Sizing

- First design engineer opinion
major plant expansion
- Second opinion
existing capacity adequate
- Actual maximum load
handled by existing capacity

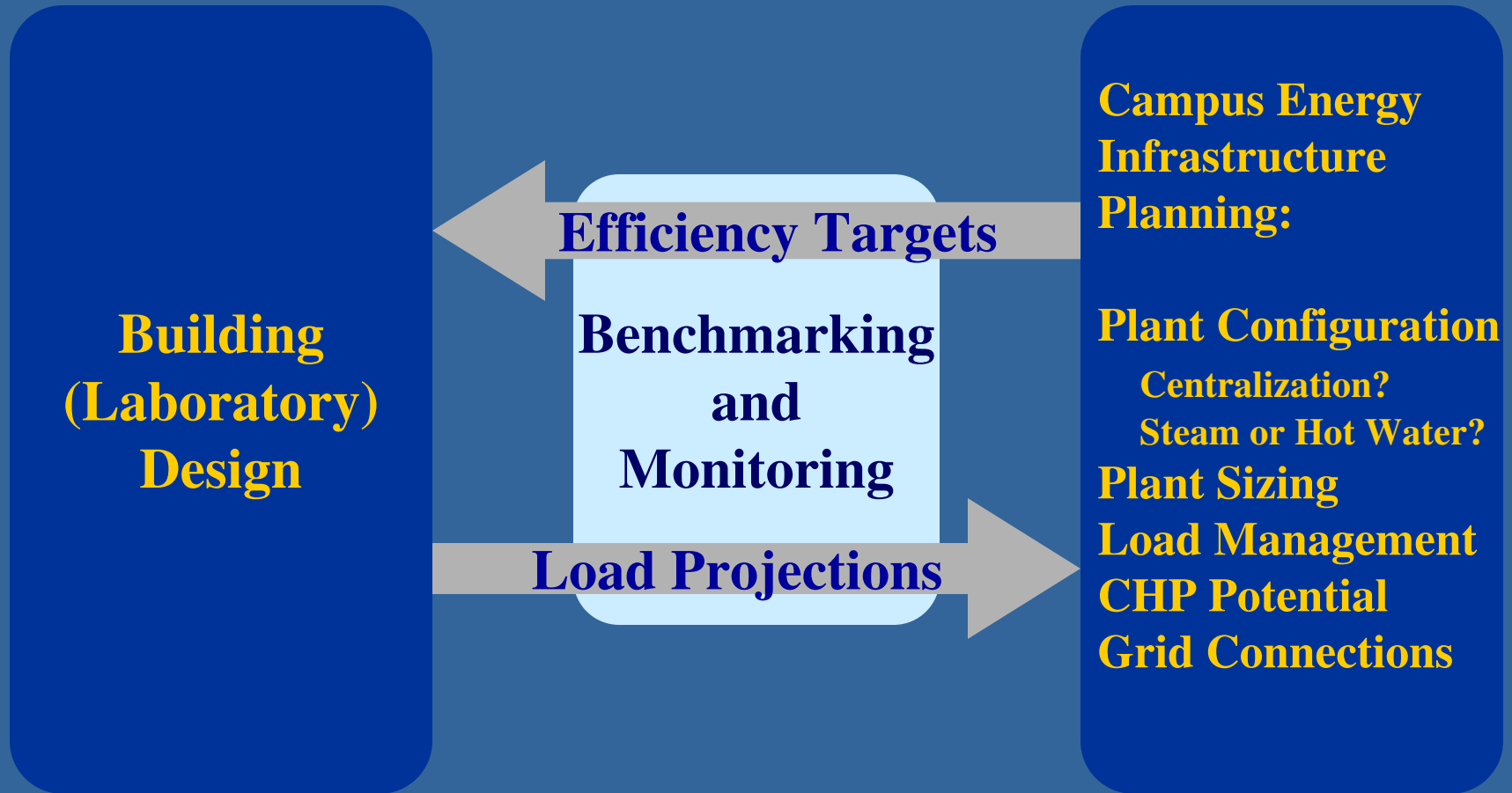
Project Management Challenge: Over Sizing of HVAC Plants

Underlying Problem:

Lack of feedback from operating experience to the design process

Benchmarking and Monitoring

Closing the Loop for Infrastructure and Building Design



Benchmarking and the MLM (Most Likely Maximum) Method

Summary Description

1) Make (MLM) estimates of actual loads:

- Calibrate with benchmarks based on actual operating conditions
- Increase diversity when moving up from zone to plant level

2) Consider MLM and part loads in system selection and optimization

3) Identify “design” capacity for each system:

- Document “margin of safety” for each level (e.g. zone, air handler, plant)
- Decrease margin of safety when moving up from zone to plant level
- “Value engineer” margins of safety

Benchmarking and the MLM (Most Likely Maximum) Method

Sources of Benchmark Data

- ◆ **Operating Data from Other Similar Facilities**
 - e.g. other UC/CSU campuses for UC Merced planning and design
- ◆ **One Time Measurements of Loads in Similar Facilities**
 - e.g. Montana State University EPICenter project
- ◆ **Labs 21 Benchmark Database**

Benchmarking and the MLM (Most Likely Maximum) Method

Advantages of the MLM Method

- ◆ Improves knowledge of actual maximum and part load operating conditions
- ◆ Load diversity is more fully accounted for
- ◆ Margins of safety are transparent and explicit

Benchmarking and the MLM (Most Likely Maximum) Method Related Method

Advanced Buildings Project*
EBenchmark™ DRAFT version 1.0 (soon to be released)

- ◆ **Prescriptive criteria for mechanical system design include:**
 - **Second set of calculations using “part load” conditions**
 - » **most likely load and/or “standard” operating conditions**
 - » **diversity**
 - **Efficient equipment and system operation at “part load”**

For More Information
New Buildings Institute (www.newbuildings.org)
Jim Edelson, Project Manager
Jeffrey A. Johnson, Author

***formerly referred to as “Advanced Building Guidelines”**

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Related Issue for System Selection

- ◆ **High loads in lab buildings attributed to process equipment:**
“Is it real or is it reheat?”
- ◆ **Do modeling assumptions capture variability of loads?**
 - between zones?
 - with time?
- ◆ **Is the magnitude of reheat waste reflected in analysis?**
- ◆ **Are the benefits of alternate systems fully recognized?**

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UC/CSU Benchmarking System

References

- ◆ <http://www.energy2002.ee.doe.gov/Facilities.htm>
- ◆ **Brown, K. 2002. "Setting Enhanced Performance Targets for a New University Campus: Benchmarks vs. Energy Standards as a Reference?" *Proceedings of the 2002 ACEEE Summer Study of Energy Efficiency in Buildings*. 4:29-40. Washington, D.C.: American Council for an Energy-Efficient Economy.**

Benchmarking and the MLM (Most Likely Maximum) Method

UC Merced Experience

- ◆ Chiller Plant Sizing
 - Full Success
- ◆ Boiler Plant Sizing
 - Partial Success
- ◆ Air System Design
 - Partial Success
- ◆ System Selection
 - Partial Success



Benchmarking and the MLM (Most Likely Maximum) Method

UC Merced Experience

◆ Initial Conclusion:

- Success depends on the quality and applicability of the benchmark data

